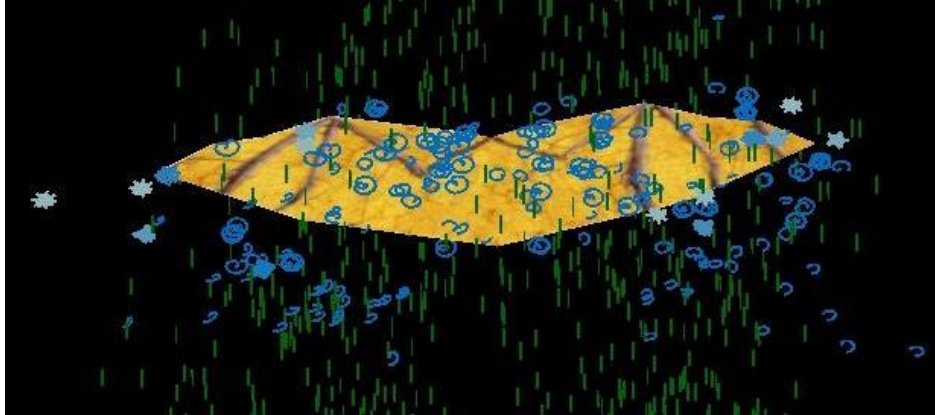


# Super Group - Final Report

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## Overview

Our goal for this project was to produce a legible and aesthetically pleasing environment that displays a bat and flow icons all in a coherent, intuitive and pleasing manner. These icons convey flow direction, pressure, speed and vorticity. The original virtual bat was not an aesthetically pleasing nor aesthetically useful part of the simulation. There were two major problems with the bat that we attempted to fix. The first was that the bat was simply an unappealing visual entity. The second was that it was very unclear which bat was oriented, and which way it was flying.

## The Bat

To fix the first problem, that is, to improve the appearance of the bat itself, was a somewhat complicated matter. The flow data that is being visualized is computed using the flat model of the bat. Thus, adding any geometry to the bat, for example a head, feet, or a body, would render the flow scientifically inaccurate for the model. Thus, our plan to improve the appearance of the bat used only the given model and did not expand upon it. We texture mapped the bat with a texture that shows vein structure and has the appearance of real bat skin. While this does not provide significant scientific feedback, it does provide scientists with a more recognizable bat. This bat will not distract the scientists from the information displayed in the flow icons, yet it will be a distinguishable entity unto itself.

## The Environment

It is easier to address the second problem, which is that both the direction and orientation of the bat were unclear in the cave. We solved this by placing the bat inside a virtual environment. This

environment was modeled after a natural cave, having stalagmites and stalactites to enhance the overall experience and to provide visual clues as to the flight direction and orientation. Additionally, to provide a better sense of the speed of the bat we created a fake parallax effect by using multiple layers of background textures, with the layers closer to the bat moving faster than those farther away.

## Icons

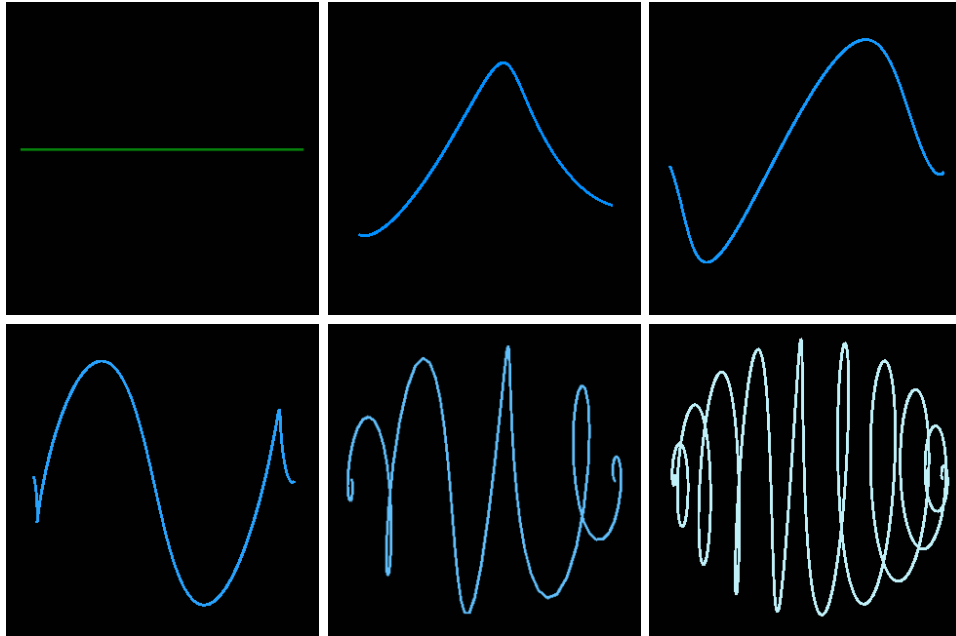


Figure No. 2 - Vorticity Spirals at vorticity levels of 0, 0.5, 1, 2, 5, and 10.

To visualize the flow of air during bat flight we created flow icons to show speed, direction and  $\lambda_2$ , the tendency of vorticity. The icon is double coded to display  $\lambda_2$ , both changing color and shape with the change in value. The color range is green in areas of zero or positive  $\lambda_2$ , and goes from dark blue when  $\lambda_2$  is small (close to zero), to light blue when it is large (large negative value). Additionally, the icon changes shape according to the following rules. In an area of positive  $\lambda_2$ , it is a straight line pointing in the direction of the flow. As  $\lambda_2$  decreases, it maintains the original axis of direction, however the middle of the line will appear to be wrapped around a ball. The more times it is wrapped, the higher the vorticity. This can be seen in Figure No. 2.

## Interaction

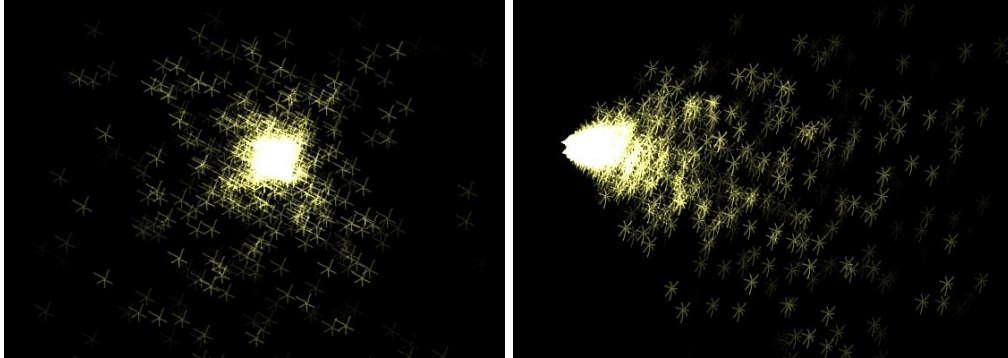


Figure No. 3 - The Sparkler being held steady, and being blown to the right.

Interaction with our virtual environment takes place through the use of two wands and a pop-up menu. One wand can be used both for placing the bat within the world, and for rotating the entire world. Rotating the world can be quickly accomplished by simply clicking on the bat with the wand moving your hand. This will turn the bat into essentially a trackball, and as your hand moves, you spin the trackball, thus rotating the entire world.

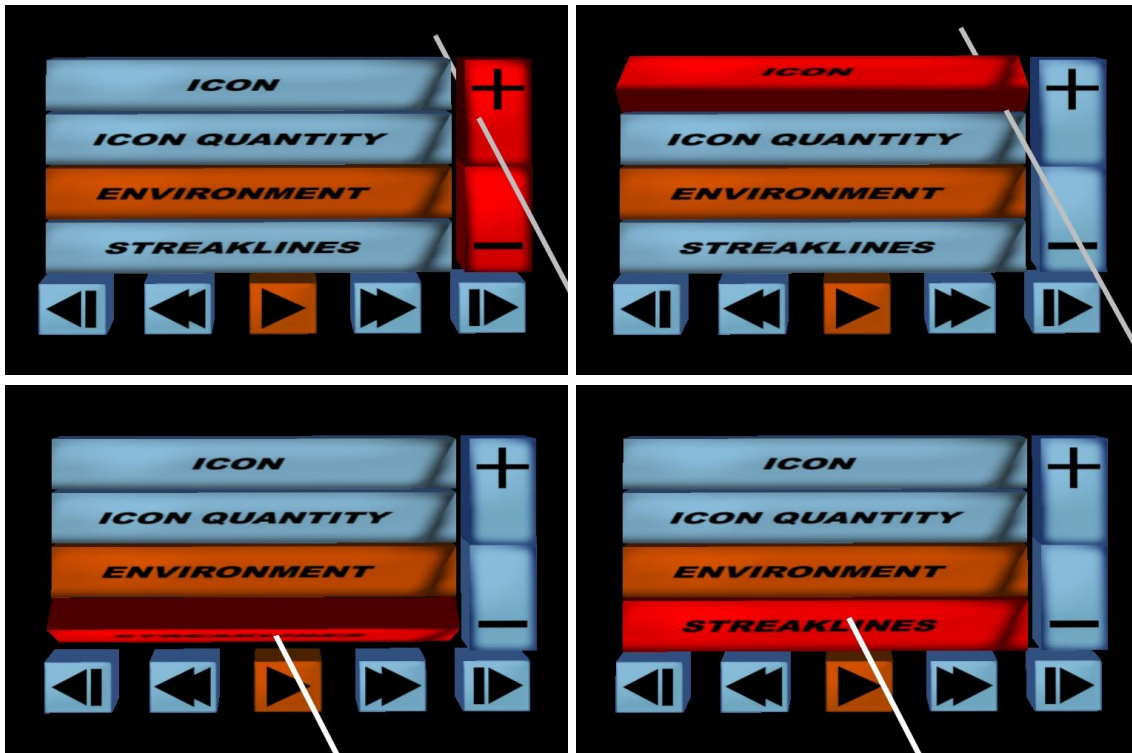


Figure No. 4 - The laser pointer interacting with the menu.

We also have a wand which is used as both a "Sparkler Tool" and a laser pointer. When the Sparkler Tool is selected, sparkles emanate from the tip of the wand. This can be seen in Figure No. 1. The sparkles provide the user with an intuitive guide point for the use of the sparkler. The sparkler emits smoke particles which then flow through the flow field. They are always emitted from the tip of the wand and provide the user with a simple way to see streaklines within the flow.

Clicking on the right button on the wand makes a pop-up menu appear wherever the wand is pointing. We make this menu a pop-up menu to allow the user to look at the data without having to constantly reposition the menu, and to avoid oversaturation of light on the walls. When the menu is active, the wand becomes a laser pointer that can be easily used to select options on the menu. The menu allows the user to interact with the visualization component of the project by toggling on and off the flow icons, the environment and the smoke emission and controlling the number of flow icons being displayed at any given time. The menu also allows the user to control the simulation by playing/pausing the simulation, controlling the speed of the simulation while it is playing, or stepping forwards or backwards in the simulation while it is paused.

## The Result

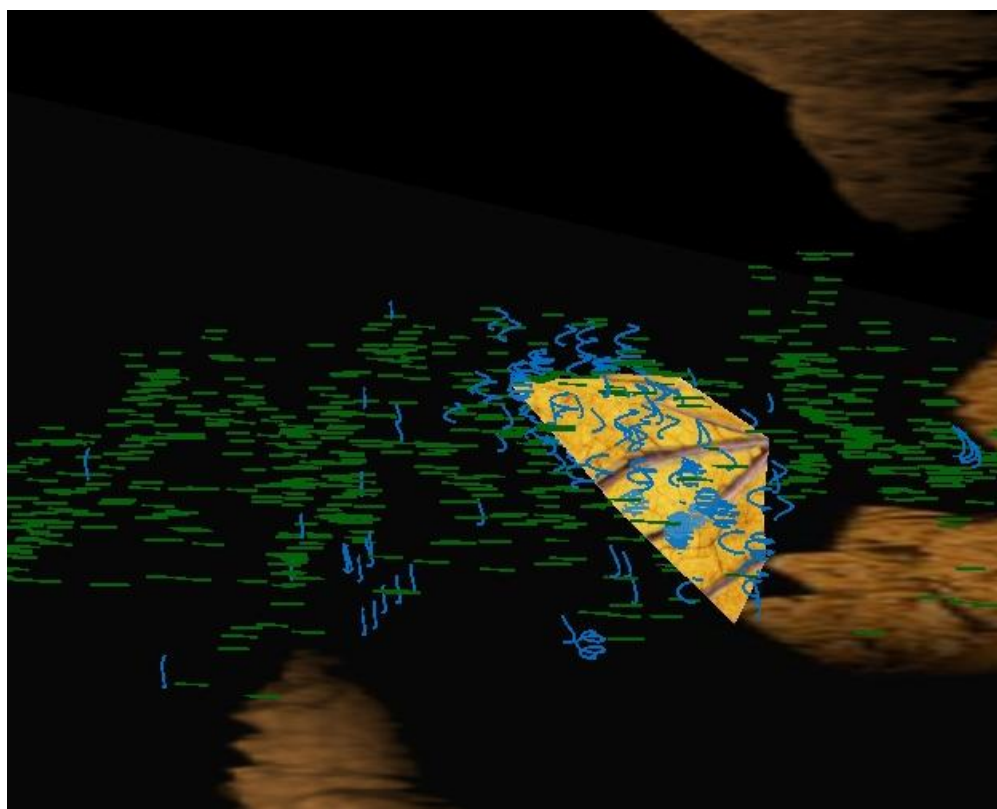


Figure No. 5 - The bat flying through the virtual environment.

We believe that we created a visualization that is pleasant to look at while remaining easy to interpret and easily usable with minor explanation. We feel that our visualization effectively deals with the issue of conveying the speed and direction of the bat and which allows the bat to be connected to its natural environment. Additionally, we believe that our visualization will help in better understanding the data available both through icons that are more clear than those previously available and through the new interaction method of being able to release smoke particles into the flow to see streaklines. In the end we hope that our visualization has features that will be desirable to scientists already working with bats as well as making it easier for a first time user to interpret what is going on.